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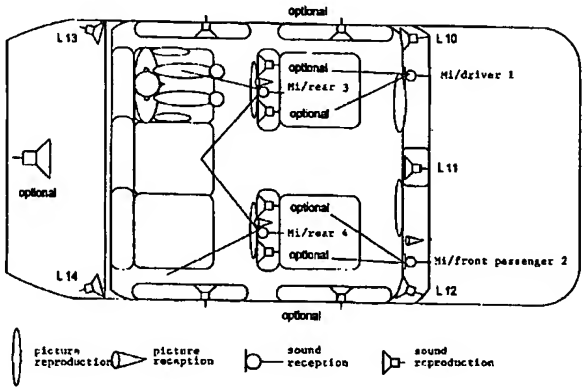
(54) PROCEDE ET DISPOSITIF POUR AMELIORER LA COMMUNICATION DANS UN VEHICULE
(54) METHOD AND DEVICE FOR IMPROVING COMMUNICATION IN A VEHICLE

(57)

The invention relates to the improvement of communication in a vehicle, whereby speech signals generated by passengers in a vehicle are recorded individually by specially arranged microphones (M1-M4). The individually recorded speech signals from each passenger (1-4) are amplified separately in an input step (7) and filtered in order to minimize start levels and adapt frequencies. Said signals are processed individually for each output channel, whereby correction of propagation time and level differentiation is performed and each signal is separated via by means of an adaptation step (9), which comprises level adaptation, amongst equally individually on specially assigned loud speakers (L10-L14), according to spatial conditions prevailing in the vehicle and in accordance with the desired volume. The inventive method is for passenger vehicles. Utilization of said invention in larger vehicles e.g. in special, multimedia bus vehicles, and in load-carrying vehicles and other means of transport such as ships, trains and aircraft is however also conceivable.



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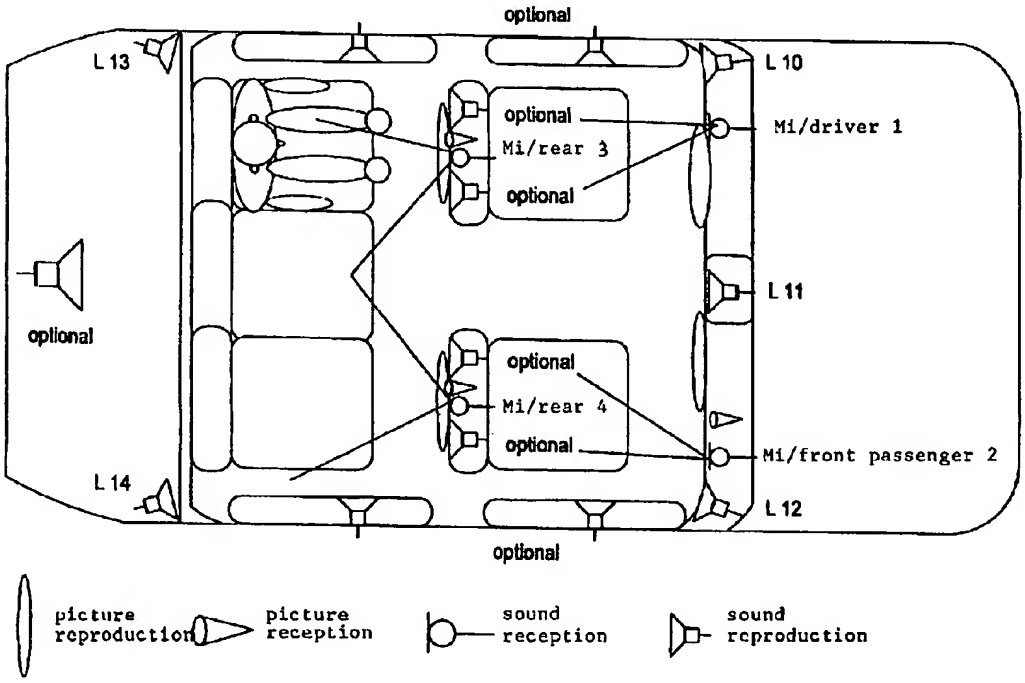

(57) Abrégé/Abstract:
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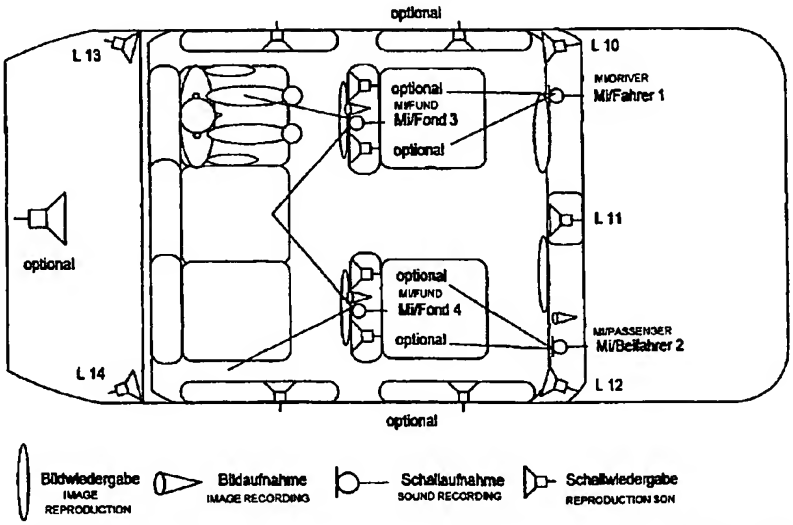
(54) Title: METHOD AND DEVICE FOR IMPROVING COMMUNICATION IN A VEHICLE

(54) Bezeichnung: VERFAHREN UND ANORDNUNG ZUR VERBESSERUNG DER KOMMUNIKATION IN EINEM FAHRZEUG



(57) Abstract: The invention relates to the improvement of communication in a vehicle, whereby speech signals generated by passengers in a vehicle are recorded individually by specially arranged microphones (M1-M4). The individually recorded speech signals from each passenger (1-4) are amplified separately in an input step (7) and filtered in order to minimize start levels and adapt frequencies. Said signals are processed individually for each output channel, whereby correction of propagation time and level differentiation is performed and each signal is separated via by means of an adaptation step (9), which comprises level adaptation, amongst equally individually on specially assigned loud speakers (L10-L14), according to spatial conditions prevailing in the vehicle and in accordance with the desired volume. The inventive method is for passenger vehicles. Utilization of said invention in larger vehicles e.g. in special, multimedia bus vehicles, and in load-carrying vehicles and other means of transport such as ships, trains and aircraft is however also conceivable.

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Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(57) Zusammenfassung: Die vorliegende Lösung dient der Verbesserung der Kommunikation in einem Fahrzeug. Dies wird dadurch erreicht, dass die Sprachsignale der Insassen des Fahrzeugs einzeln über gesondert angeordnete Mikrofone (M1-M4) aufgenommen werden. Die einzeln aufgenommenen Sprachsignale werden dann für jeden Insassen (1-4) getrennt in einer Eingangsstufe (7) verstärkt und zur Startpegelminimierung und Frequenzanpassung gefiltert, in einer Prozessstufe (8) einer für jeden Ausgangskanal individuellen Signalverarbeitung in Form einer Laufzeitkorrektur und einer Pegeldifferenzierung unterzogen und über eine Anpassstufe (9) mit einer Pegelanpassung auf ebenfalls gesondert zugeordnete Lautsprecher (L10-L14), entsprechend den räumlichen Bedingungen des Fahrzeugs und der gewünschten Lautstärke, aufgeteilt. Die erfindungsgemäße Lösung ist insbesondere für PKW konzipiert. Denkbar ist jedoch auch die Anwendung in größeren Fahrzeugen, wie beispielsweise in speziellen, als Multimediabusse ausgebildeten Fahrzeugen, sowie auch in Lastfahrzeugen und anderen Verkehrsmitteln, wie Schiffen, Bahnen und Flugzeugen.

[2345/176]

METHOD AND SYSTEM FOR IMPROVING COMMUNICATION IN A VEHICLE

The present invention is directed to optimizing the supplying of sound, and thus to improving, in particular, internal communication in vehicles.

Using current technology, level controllers can be used to assign the mostly two-channel signal components, made available via storage media or audio transmissions, to loudspeakers, at different level components, as dosed signal components. In approaches that follow the above principle, the signals are distributed over all existing loudspeakers exclusively on the basis of a level distribution determination.

From German Patent DE 196 20 980, an audio device for a vehicle is known, where phone conversations are processed using an appropriate voice- or signal-controlled allocation, such that an allocation to the individual engaged in the phone conversation is made, but also in such a way that the positioning can be freely defined purely by an intensity control.

In addition, from German Patent 43 08 398, an approach is known for an active noise reduction system for the passenger compartment of a motor vehicle, which is directed to diminishing vibrational noises generated by a four-cylinder, four-stroke engine and transmitted to the passenger compartment. Approaches directed to reducing noise in passenger compartments are, in fact, able to create better conditions, both for internal communication within the passenger cell, as well as for external communication from the passenger cell to the outside, for example via radio paging. This means that such systems may, in fact, be able to reduce disturbing noises, but they are not able to completely

compensate for these noises.

Even when engine and driving noises are reduced to the greatest possible extent, the underlying problem of communication within a passenger cell still persists. This is due, in particular, to the seating arrangement within the passenger cell. In order to communicate well within the passenger cell, particularly in conversations involving individuals in the front as well as in the rear areas of the passenger cell, each person participating in the conversation is forced to make himself/herself understood by changing his/her posture and/or by raising the volume of his/her own voice. In concrete terms, this means that the driver and front-seat passenger must turn their heads around somewhat to the back and that the rear passengers, for the most part, have to lean forward somewhat to be able to understand one another clearly. A situation of this kind impairs the driver's concentration, in particular, and thus attentiveness and, in general, therefore, jeopardizes road safety.

From German Patent 34 131 81, a large-room acoustic irradiation system is known for radiating large rooms or open spaces with sound according to principles of support or simulation, which is approximately true to time and, to the extent that is necessary, to sound level, of sonic fields propagating from the source via the area of action into the reception area, with a temporal source priority. This means that the acoustic radiators do not radiate until after the wavefronts of the original acoustic sources, i.e. of the acoustic radiator simulating these and of the acoustic radiators closer to the source, have passed, and that the time intervals or the amplifications are differentiated by capacity and type of source. This approach solves the contradiction between propagation-delay and amplitude localization, even in transition regions where it is usually the first audible acoustic radiator that is located, instead of the original sound source, when the comparison is made. Accordingly, the

approach is directed to the source, the area of action, and the acoustic radiator locations, and considers the acoustic capacity of the sources.

Furthermore, a multichannel sound reproduction method and apparatus are known from European Patent 0 712 264. The goal of this approach is to reproduce multichannel sound programs as adapted programs, but virtually in conformance with the standard.

In contrast to the above described approaches, the applicant's approach is directed to sound signals which are picked up in a room and are intended to be output again in the same room, subject to observation of their position and their spatial characteristics. Accordingly, the delimitation from the related-art approaches is also evident.

The technical objective underlying the present invention is directed, in particular, to improving the communication among the individuals located inside the passenger cell of a vehicle, while also improving the communication between these individuals and voice-communication systems outside of the vehicle. The technical objective is, therefore, directed, in particular, to picking up and reproducing signals in a closed space, the intention being to take into account the position and the characteristic of the picked-up signals during reproduction.

In accordance with the present invention, the communication is implemented in the passenger compartment of a vehicle by a method and a system for improving communication, which are directed to a complex way of picking up and reproducing voices. In this context, a microphone M1-M4 and a loudspeaker array L10-L14 are assigned to each seat at the appropriate location (seat or head position). The voice signals picked up by microphones M1-M4 are distributed via a processor circuit among all or at least among a large portion of built-in

loudspeakers L10-L14 at different levels and different propagation delays, as a function of the pick-up position and the positions of the reproduction devices. At the same time, the frequency is influenced in the receiving channel to limit the interfering signal components and to adapt the sound and, in the reproduction channel, to adapt the acoustics of the space to the loudspeaker position and to the passenger compartment determined by the vehicle type.

Via microphone M1-M4 assigned to the individual who is speaking in the particular instance, a received voice signal attains an input stage 7 having a microphone amplifier 7a and the associated level adjustment, as well as input filter 7b for interference level minimization and frequency adaptation. The signal then attains process stage 8, where it is split into as many signal paths as there are output channels present. In these signal paths, in dependence upon the allocation of output channels to each signal path, a signal processing is undertaken in the form of a delay correction via a module to delay correction 8a, and a level differentiation is performed via a module to level differentiation 8b. The level differentiation first considers the position of the signal reception (microphone M1-M4), and secondly the positions of loudspeakers L10-L14, distributed in an array, which are connected to the individual output channels. Each signal path is connected on the output side to a summing stage 8c and to a distribution stage 8d, whose number conforms to the number of output channels, in order to assign, from each input path, the signal that is picked up by the individual microphones M1-M4 and is processed separately in each of the signal paths, to the individual output paths. This ensures that the input signal(s) is/are able to be reproduced in a specific form by each loudspeaker L10-L14. Following summing stage 8c and distribution stage 8d, the processed signal attains an adaptation stage 9 having the number of channels intended for supplying the signal to all loudspeakers L10-L14 considered to be necessary. When multichannel sound programs

are transmitted for a four-passenger vehicle, it is necessary to increase the number of loudspeakers by at least one additional, fifth loudspeaker. In adaptation stage 9, a further level adaptation is performed via a module for level adaptation 9a, and a frequency adaptation is performed via a room-correction filter for frequency adaptation 9b, which is intended to allow for the spatial conditions of the vehicle. At the same time, it is possible to devise the influencing of sound level on an individual basis. Other input channels 5/6 and output channels 15/16, respectively, linked to input stage 7 and to adaptation stage 9, are provided for external connections, such as telephones, for recording possibilities, for participation in video conferences, inter alia. The signal processing and signal allocation enable the voice signal picked up at any one time inside the vehicle to be distributed over the loudspeaker array in such a way that the internal communication is substantially improved.

The communication system according to the present invention is elucidated on the basis of an exemplary embodiment for a vehicle having five seats, in accordance with Figure 2.

In the described exemplary embodiment, a microphone array and a loudspeaker array are allocated to each seat, at the appropriate location. In this context, the microphone array is made up of microphones M1-M4. In the front area, the vehicle's dashboard offers a practical solution for mounting microphones M1-M2. When directional microphones are used, a side mounting in the respective door moldings is also possible, for example. In the rear area of the passenger cell, microphones M3-M4 are preferably mounted in the seat backs of the front seats, or in the case of directional microphones, in the sides of the vehicle body. Normally, an individual microphone is not allocated to the fifth passenger, whose seat is located between the seats of passengers 3 and 4. He/she has the option of using microphones M3 and M4. Microphones M1-M4 are connected to an input stage 7, which is composed of n-channel

inputs to level- and frequency influencing 7a/b, n corresponding to the number vehicle occupants. The inputs may be switched over via a switching element to incoming signals from the outside (input external information channels DVB/DAB/ISDN 5) and/or from internal storage media (input audiovisual internal storage devices CD/DVD/MTG 6). In a process stage 8 downstream from input stage 7, the incoming input signals from microphones M1-M4 are processed via modules for delay correction $8a_{1-5}$ using different delay times and via models for level differentiation $8b_{1-5}$ using different levels, summed in summing stages $8c_{1-5}$, and distributed via distribution stages $8d_{1-5}$ over the selected output channels. The differentiated distribution and the outputting of the voice signals to individual loudspeakers L10-L14 takes place via an adaptation stage 9 having room-correction filters $9b_{1-5}$ and level-adaptation stages $9a_{1-5}$. The incoming signals are processed in accordance with their content (telephone signal, multimedia signal, inter alia) using signal engineering and distributed among loudspeakers L10-L14, tailored to the reproduction device.

If needed, a switchover may be made to outputs for external information channels 15/16.

The above described sound-engineering system may also be coupled, for example, to a central picture-reproduction device 19 or to a picture receiving device 19_{1-4} assigned to the individual seats. A complex multimedia use of the communication system is thus possible.

The system is controlled via a control unit 17 in which preset settings and usage variants are stored as retrievable set-ups. In addition, control unit 17 is linked to a central operating unit 18, which is preferably assigned to the driver and thus enables influence to be exerted in a centralized fashion, and is linked to distributed operating units 18_{1-4} assigned to the individual seats. It is likewise possible for control unit 17

to be driven by external signals. By utilizing a mutually complementary and effective propagation-delay and level correction along the lines of the present invention, a simultaneous processing and seat-independent reproduction of a plurality of sound centers, i.e., signal sources, up to the inclusion of multichannel stereophony, is ensured inside the passenger cell. This special signal processing substantially improves the acoustic decoupling of the receiving and reproduction channels as merely a pure amplification optimization.

Additional input filters inserted into the particular intended microphone inputs of microphones M1-M4 are used to attenuate the internal noise signals as interference components and to optimize the microphone signals. The sound adaptation is optimized in the particular vehicle preferably by way of output filters. The communication system in accordance with the present invention is also able to be advantageously used for other usage variants which are directed to communication with external users. Thus, a use as a telephone device having a free assignment of users within the vehicle is possible. A variant is also conceivable where the approach according to the present invention is designed as a video-conferencing system. Another possible use is to retrieve multimedia program material from internal memories or from externally received signals.

In the case of a use within the framework of telephone processes, the structure of the approach of the present invention makes it possible for a conversation to be assigned, for example, to each seat and, thus, to each occupant. In this context, the reproduction may take place as a controlled process via selected loudspeakers, so that even selected vehicle occupants may participate in the phone conversation. At the same time, it is possible to limit the extent to which other occupants in specific seats overhear the conversation. This is done by switching the incoming signal to loudspeakers

chosen for this and by processing it as a fictive, i.e., virtual voice source. The outgoing signal(s) undergo(es) the same process as the signal which is utilized for the internal communication. It is likewise possible to adjust the manner in which specific seats or areas are separated both from the receiving, as well as from the reproduction side, using operating units of control unit 17. Therefore, the possibility is given to hold telephone conferences. Another conceivable variant provides for the inclusion of video signals. For a variant of this kind, the vehicle must additionally be equipped with picture-receiving and reproduction devices. In this manner, the precondition is created for a video conference with external remote terminals. At the same time, it is possible to use the picture devices for TV programs and multimedia services. The audio signals are assigned accordingly, so that an optimal multichannel reproduction may follow for each seat.

The individual usage variants are preferably combined in a control program and may be fetched both by central operating unit 18 in the vicinity of the vehicle driver, as well as, to a limited degree, by the individual vehicle occupants, in that a simplified variant of operating unit 18_{1-4} is provided in the vicinity of the individual seats.

When internally stored or externally supplied programs are reproduced in picture and/or sound, the single- or multi-channel signals may likewise be assigned to the individual internal seats or supplied areas. In this context, a recording on available storage media may take place, for example, via connections having preselected output channels 1-n.

By distributing the microphone signals over all loudspeakers L10-L14 using different signal processing (propagation delay and level), the approach of the present invention achieves an excellent intelligibility in the entire area of the vehicle

passenger cell, while at the same time minimizing the danger of feedback coupling by employing appropriate control mechanisms. Each occupant is able to freely select whether he/she would like to participate in the communication.

Moreover, the possibility is given for a further combination with multimedia services in a simple form. These include phoning from each seat, but also shared phone conference applications, including a simultaneous integration of the picture reproduction and reception, both for the front seats, as well as for the seats in the rear area. However, this system also makes it possible to improve the utilization for existing information, i.e., information to be received, for example, via radio and/or television broadcasts.

The approach according to the present invention is especially conceived for passenger cars. However, one can also conceive of applications in larger vehicles, such as in special vehicles designed as multimedia buses, as well as in trucks and in other means of transportation, such as ships, trains, and airplanes. However, these would require a larger number of receiving and reproduction channels, i.e., reproduction devices, and custom tailored signal processing units.

Reference Numeral List

1-5	occupants of the vehicle
M1 - M4	microphones
5	input audiovisual internal storage devices
6	input external information channels DVB/DVD/ISDN, etc.
7	input stage
7a	microphone amplifier
7b	input filter for minimizing interference level and for frequency adaptation
8	process stage
8a	module for delay correction
8b	module for delay differentiation
8c	summing stage
8d	distribution stage
9	adaptation stage
9a	module for level adaptation
9b	room correction filter for frequency adaptation
L10 - L14	loudspeakers
15; 16	output external information channels ISDN, etc.
17	control unit
18	central operating unit
18_{1-4}	operating units assigned in decentralized fashion to the individual seats
19	central picture-reproduction device
19_{1-4}	picture-reproduction device assigned to the individual seats

What is claimed is:

1. A method for improving communication in a vehicle, wherein

a) the voice signals of the occupants of a vehicle are picked up on an individual basis for each occupant via a microphone (M1-M4) assigned to him/her within the area of his/her seat, the picked-up voice signals being amplified separately for each occupant in an input stage (7) and being filtered for purposes of interference level minimization and frequency adaptation;

b) for purposes of distribution to the output channels and, thus, distribution to the individual components of a voice-output device made up of loudspeakers (L10-L14), the amplified and filtered voice signals of each individual occupant, via a summing and distribution stage (8c;8d), undergo a signal processing specific to each output channel in the form of a delay correction and a level differentiation, in a process stage (8) as a function of the local allocation of the microphone (M1-M4) in the vehicle, via which the voice signal was picked up, and as a function of the local allocation of each individual loudspeaker (L10-L14) of the voice-output device in the vehicle via which the voice signal is intended to be output; and

c) the voice signal processed on an individual basis for each output channel is assigned to the individual output channels and, thus, to the individual loudspeakers (L10-L14) of the voice-output device via an adaptation stage (9) in which, via a level adaptation and a frequency adaptation, an adaptation of the particular voice signal to the spatial conditions of the vehicle and to the desired sound level is tuned to each output channel and, thus, to each loudspeaker (L10-L14) of the voice-output device

Revised Claims

2. The method as recited in Claim 1,
wherein, via input channels (5;6) connected to the input stage (7), signals, supplied from internal audiovisual storage devices or from external information channels, are transmitted as tuned to the spatial conditions of the vehicle, via the process stage (8) and the adaptation stage (9), to the individual output channels and, thus, in dependence upon the type of signal, to the individual loudspeakers (L10-L14) and/or to the individual components for picture reproduction.

3. A system for improving communication in a vehicle,
wherein, assigned to each seat is a microphone (M1-M4) of a voice pick-up device and at least one loudspeaker (L10-L14) of a voice-output device;
the individual microphones (M1-M4) of the voice pick-up device are connected via an input stage (7), made up of a microphone amplifier (7a) and an input filter (7b), designed to minimize interference levels and for frequency adaptation, to a process stage (8), made up of a [propagation-]delay correction module (8a), a level differentiation module (8b), a summing stage (8c) and a distribution stage (8d);
the process stage (8) is linked via an adaptation stage (9), made up of a level adaptation stage (9a) and a room correction filter (9b) designed for frequency adaptation, to the individual loudspeakers (L10-L14) of the voice-output device;
and both the input stage (7), as well as the process stage (8) and the adaptation stage (9) are linked to a control unit (17), to which a central operating unit (18) is connected.

4. The system as recited in Claim 3, wherein, the adaptation stage (9) is connected to at least one external information channel (15;16).

5. The system as recited in Claim 3, wherein the process stage (8) is connected to at least one internal audiovisual storage device (5) and/or to at least one external information channel (6).

~~one internal audiovisual storage device (5) and/or to at least one external information channel (6)~~.

6. The system as recited in Claim 3,
wherein the input stage (7) is connected to at least one external information channel, which is likewise connected via the process stage (8) and the adaptation stage (9) to the loudspeakers (L10-L14) of the reproduction device.

7. The system as recited in Claim 3,
wherein the central operating unit (18) is assigned to the front-passenger seat.

8. The system as recited in Claim 3,
wherein the control unit (17) is additionally connected to at least one operating unit (18_{1-4}) that is assigned to a further seat and has limited functioning.

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Patent Agents

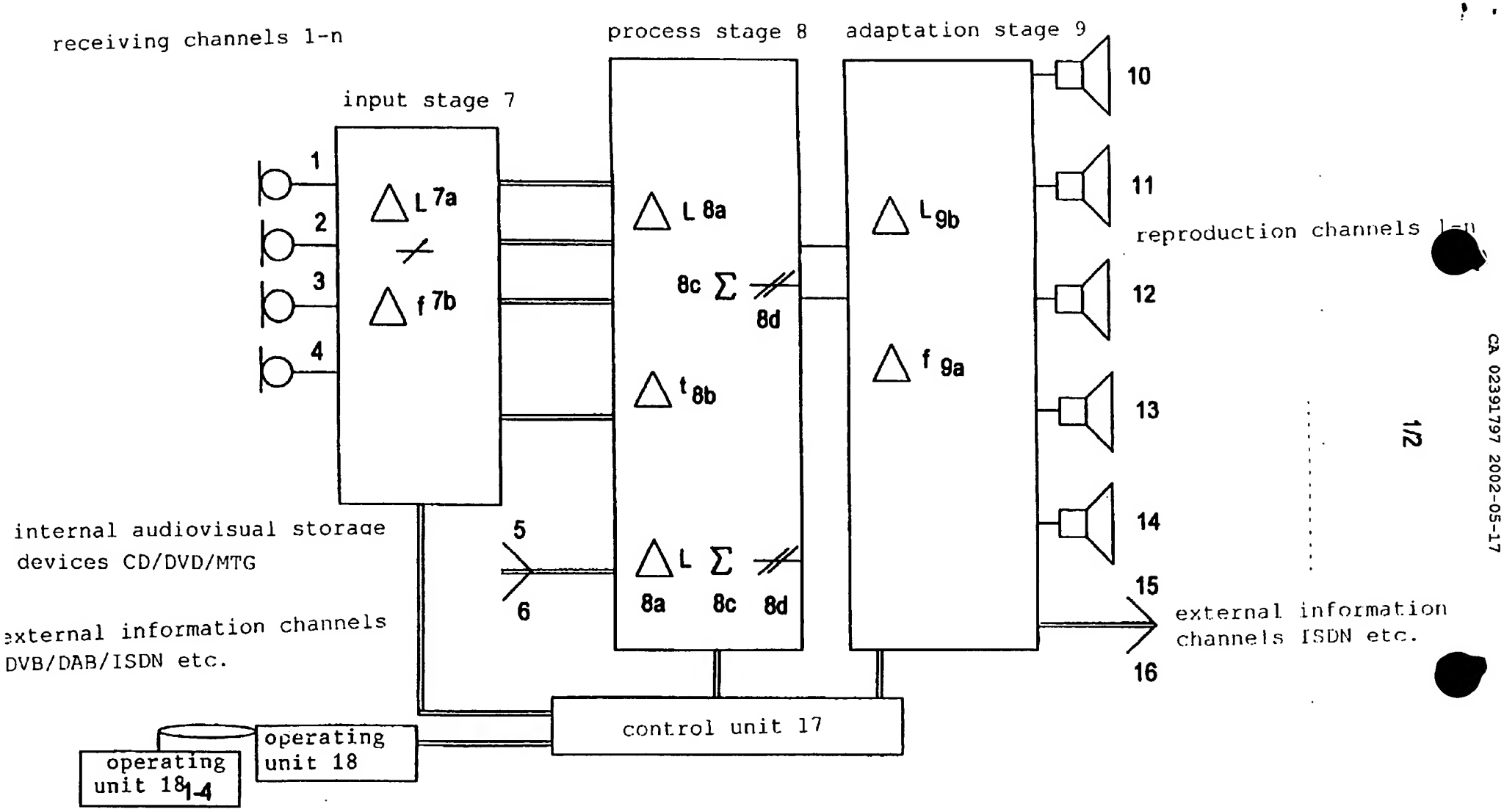

Fig. 1

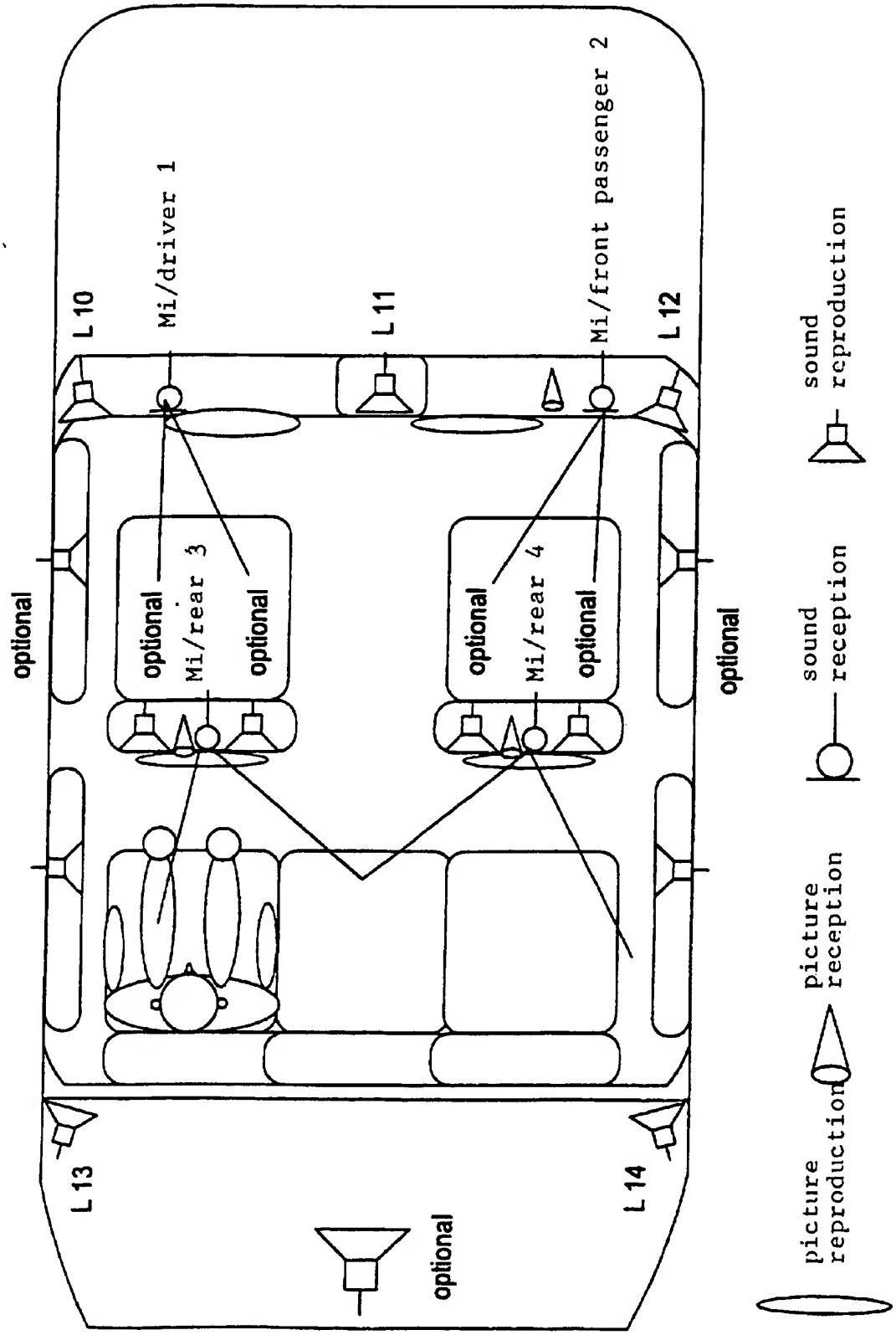
L 10
Mi/driver 1
L 11
Mi/front passenger 2
L 12
optional
optional
Mi/rear 3
optional
optional
optional
Mi/rear 4
optional
optional
L 13
L 14
optional
picture reproduction
picture reception
sound reception
sound reproduction

Fig. 2